# An Intelligent High-Altitude Fire-Fighting Apparatus

## Technical Field

The present invention relates to the technical field of building fire protection, and in particular to an intelligent high-altitude fire-fighting apparatus.

## Background Art

With the development of cities, available land in cities is decreasing day by day. High-rise buildings can effectively save floor area, but at the same time the population density in high-rise buildings is relatively high, and the consequences of a fire are very serious. Fire is a type of major safety accident, and it is extremely harmful to the safety of people's lives and property.

Patent document CN115970184B discloses a multifunctional building fire-extinguishing device having a window-breaking structure. By loading chemical reaction-type raw material packages, the fire-extinguishing device can be reused. When the device is not in use, the two raw material packages do not react in a sliding cavity, no pressure is formed inside the fire-extinguishing device, and safety performance is good. A fixed disc of the fire-extinguishing device is provided with an overpressure breaking sealing plate, so as to prevent an explosion-proof cover from bursting because pressure is too high and exceeds an engaging force between the explosion-proof cover and a movable disc. When the pressure exceeds a preset value, the overpressure breaking sealing plate can rupture to release pressure. After activation, the spraying duration is longer than that of a conventional fire extinguisher of the same volume. A window breaker is provided. The window breaker adopts a compression spring-type structure, so that a first hammer head generates large kinetic energy in a short time and can effectively strike window glass. A second hammer head is further provided outside the window breaker. The function of the second hammer head is the same as that of a conventional window breaker, namely striking window glass by holding a body of the window breaker. A guide groove is added in a cylinder body of the window breaker, so that the movement direction of the first hammer head is more stable. A deceleration spring is added in the cylinder body of the window breaker, so as to avoid rigid contact between the first hammer head on the window breaker and an end of the guide groove. A shockproof pad is added on a straight rod of the window breaker, so as to avoid rigid connection between the second hammer head and a fixed cover.

Although the above multifunctional building fire-extinguishing device having a window-breaking structure can solve corresponding technical problems, the whole window-breaking and fire-extinguishing operations thereof both require manual

operation by personnel. However, when a dangerous situation is severe, trapped persons in a building have difficulty in promptly finding a fire-extinguishing device in a building fire passage and making correct self-rescue operation, and it is very easy to miss the optimal fire-extinguishing timing. For this reason, an intelligent high-altitude fire-fighting apparatus is proposed.

**Summary of the Invention**

The technical task of the present invention, in view of the above deficiencies, is to provide an intelligent high-altitude fire-fighting apparatus. Through cooperative use of a fire-extinguishing cabin, a hoisting mechanism, a vertical guide mechanism, a fire-extinguishing mechanism, a second automated guided vehicle, a horizontal guide mechanism, a support mechanism and a window-breaking mechanism, it is possible to automatically and promptly perform a fire-fighting or rescue task at any location around a building, thereby solving the above problems.

To achieve the above object, the present invention provides the following technical solution:

An intelligent high-altitude fire-fighting apparatus comprises:

a fire-extinguishing cabin, configured to provide an installation base for a portion of the intelligent high-altitude fire-fighting apparatus and to assist in evacuation and rescue of trapped persons in a building, wherein the fire-extinguishing cabin is movably arranged outside the building;

a hoisting mechanism, configured to drive the fire-extinguishing cabin to move upwards and downwards, wherein the hoisting mechanism is arranged on a roof of the building, and the fire-extinguishing cabin is arranged below the hoisting mechanism;

a vertical guide mechanism, configured to guide upward and downward movement of the fire-extinguishing cabin, wherein the vertical guide mechanism is arranged between the roof of the building and the ground;

a fire-extinguishing mechanism, configured to cooperate with the fire-extinguishing cabin to perform fire-extinguishing operation on a fire source in the building, wherein the fire-extinguishing mechanism is arranged on the roof of the building;

a second automated guided vehicle, configured to drive the hoisting mechanism, the vertical guide mechanism and the fire-extinguishing mechanism to synchronously perform horizontal movement, wherein respective structural portions of the hoisting mechanism, the vertical guide mechanism and the fire-extinguishing mechanism are arranged on the second automated guided vehicle;

a horizontal guide mechanism, configured to guide horizontal movement of the second automated guided vehicle, wherein the horizontal guide mechanism is arranged on the roof of the building, and the second automated guided vehicle is movably arranged on the horizontal guide mechanism;

a support mechanism, configured to support respective structural portions of the hoisting mechanism, the vertical guide mechanism and the fire-extinguishing mechanism, wherein the support mechanism is arranged on the fire-extinguishing mechanism;

and a window-breaking mechanism, configured to break a glass window at the fire source of the building and to ensure stability of the fire-extinguishing cabin during fire-extinguishing operation, wherein the window-breaking mechanism is arranged in an inner cavity of the fire-extinguishing cabin.

Preferably, the hoisting mechanism comprises a first winch and a steel wire rope, the first winch is mounted on a top of the second automated guided vehicle, one end of the steel wire rope is fixed to and wound on the first winch, and the other end of the steel wire rope is fixedly connected to a top of the fire-extinguishing cabin.

The vertical guide mechanism comprises a second winch, flexible cables, a connection seat, a first automated guided vehicle and sliding assemblies. The second winch is mounted on the top of the second automated guided vehicle. Four flexible cables are fixed to and wound on the second winch. The four flexible cables are respectively slidably connected to four corners of the fire-extinguishing cabin by means of the sliding assemblies. The other ends of the flexible cables movably pass through to below the fire-extinguishing cabin and are fixedly connected to the connection seat. The first automated guided vehicle is mounted at a bottom of the connection seat. One sliding assembly is provided at each of the four corners of the top and the bottom of the fire-extinguishing cabin.

The fire-extinguishing mechanism comprises a high-pressure water pump, a water storage tank, a water delivery pipe, a hose and a fire monitor. The high-pressure water pump is mounted on the top of the second automated guided vehicle. The water storage tank is arranged on a top of the horizontal guide mechanism. One end of the water delivery pipe communicates with a water inlet end of the high-pressure water pump. The other end of the water delivery pipe extends through into an inner cavity of the water storage tank. The fire monitor is mounted in the inner cavity of the fire-extinguishing cabin. One end of the hose communicates with a water outlet end of the high-pressure water pump, and the other end of the hose extends through into the inner cavity of the fire-extinguishing cabin and communicates with the fire monitor.

One window-breaking mechanism is provided at each of an upper portion and a lower portion of the inner cavity of the fire-extinguishing cabin.

The window-breaking mechanism comprises two second hydraulic telescopic arms, manipulators and window breakers. Output ends of the second hydraulic telescopic arms are fixedly connected to the manipulators, and the window breakers are arranged on sides of the manipulators away from the second hydraulic telescopic arms.

The window-breaking mechanism further comprises a spacing adjustment assembly configured to adjust a spacing between two second hydraulic telescopic arms on the same horizontal line.

The spacing adjustment assembly comprises a bidirectional screw rod horizontally and rotatably connected in the inner cavity of the fire-extinguishing cabin. A stepper motor configured to drive the bidirectional screw rod to rotate is mounted on an inner wall surface of the fire-extinguishing cabin. Each of the second hydraulic telescopic arms is fixedly connected to a threaded sleeve. Two threaded sleeves on the same horizontal line are respectively threadedly sleeved on two sides of a surface of the corresponding bidirectional screw rod. A limiting mechanism for guiding is provided between each second hydraulic telescopic arm and the fire-extinguishing cabin.

Preferably, the sliding assembly comprises a first bracket mounted on the fire-extinguishing cabin, and one side of the first bracket is rotatably connected to two symmetrical limiting wheels slidably connected to the flexible cable.

Preferably, the horizontal guide mechanism comprises a load-bearing support mechanism configured to raise and support the second automated guided vehicle and the water storage tank, and an anti-overturning mechanism is provided between the load-bearing support mechanism and the second automated guided vehicle.

Preferably, the load-bearing support mechanism comprises a reinforcing beam fixedly connected to the roof of the building, reinforcing columns are fixedly connected to both sides of the reinforcing beam, and the water storage tank is fixedly connected to a top of one of the reinforcing columns.

Preferably, the anti-overturning mechanism comprises a T-shaped rail beam fixedly connected to tops of the reinforcing beam and the other reinforcing column, travelling wheels of the second automated guided vehicle are arranged on a top of the T-shaped rail beam, second brackets are mounted on both sides of a bottom of the second automated guided vehicle, and bottom ends of the second brackets are rotatably connected to moving wheels cooperating with the T-shaped rail beam.

Preferably, the support mechanism comprises a first hydraulic telescopic arm mounted on the top of the second automated guided vehicle, an output end of the first hydraulic telescopic arm is fixedly connected to a support seat configured to guide the

hose, and the support seat is rotatably connected to a guide wheel configured to guide and support the steel wire rope and the flexible cables.

Preferably, a third bracket is fixedly connected to a side, away from the support seat, of a top of the first hydraulic telescopic arm. A first support rod is slidably connected to a bottom of the third bracket. One end of the first support rod is fixedly connected to the support seat. A plurality of second support rods are fixedly connected to a top of the first support rod. Top ends of the second support rods are rotatably connected to rollers configured to guide and support the hose, and heights of the rollers increase successively from left to right.

Preferably, the window breaker comprises a T-shaped block fixedly connected to claws of the manipulator, a window-breaking cone is fixedly connected to a side of the T-shaped block away from the manipulator, and a plurality of regularly distributed window-breaking teeth are fixedly connected to a side of the T-shaped block close to the window-breaking cone.

Preferably, the limiting mechanism comprises two guide rods symmetrically arranged on two sides of the bidirectional screw rod. Guide sleeves are fixedly connected to both sides of a bottom of the second hydraulic telescopic arm, and the guide sleeves are slidably sleeved on surfaces of the corresponding guide rods.

Compared with the prior art, the advantages and positive effects of the present invention lie in that:

1. In the present invention, by additionally providing the fire-extinguishing cabin, the hoisting mechanism, the vertical guide mechanism and the fire-extinguishing mechanism on the roof of the building, when a fire occurs, the fire-extinguishing cabin suspended above the roof of the building can be moved to the height position of the fire source of the building through cooperative use of the hoisting mechanism and the vertical guide mechanism, and the fire-extinguishing mechanism performs fire-extinguishing operation on the fire source, thereby enabling automatic and prompt fire-fighting operation without manual operation by personnel and achieving the effects of saving physical strength of firefighters and improving fire rescue efficiency.

2. In the present invention, by additionally providing the second automated guided vehicle and the horizontal guide mechanism on the roof of the building, when a fire occurs, through cooperative use of the vertical guide mechanism, the second automated guided vehicle and the horizontal guide mechanism, the fire-extinguishing cabin can be moved to any location around the building to perform a fire-fighting or rescue task, thereby expanding the use range of the intelligent high-altitude fire-fighting apparatus.

3. In the present invention, through cooperative use of the support mechanism and the window-breaking mechanism, when a fire occurs, the support mechanism can adjust the distance between the fire-extinguishing cabin and an outer wall of the building. The window-breaking mechanism can perform a window-breaking operation on the glass window of the building and can also stabilize the fire-extinguishing cabin, so that the fire-extinguishing cabin has an anchoring point. This effectively prevents the fire-extinguishing cabin from drifting and shaking under high wind speed, thereby ensuring that the fire-extinguishing mechanism is aligned with the fire source of the fire scene for effective fire-extinguishing operation, and thus ensuring the automatic fire-extinguishing effect for a high-rise building.

**Brief Description of the Drawings**

In order to more clearly describe the technical solutions in embodiments of the present invention or in the prior art, the drawings required for use in the embodiments will be briefly introduced below. Obviously, the drawings described below are merely some embodiments of the present invention. Those of ordinary skill in the art may also obtain other drawings based on these drawings without creative effort.

Fig. 1 is a structural schematic diagram of an intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a state in which the fire-extinguishing cabin is lowered;

Fig. 2 is a structural schematic diagram of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a state in which the fire-extinguishing cabin is stabilized;

Fig. 3 is a partial structural schematic diagram of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention;

Fig. 4 is a structural schematic diagram of the fire-extinguishing cabin and the window-breaking mechanism of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a lowered state;

Fig. 5 is a structural schematic diagram of the fire-extinguishing cabin and the window-breaking mechanism of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a stabilized state;

Fig. 6 is a top structural schematic diagram of the fire-extinguishing cabin and the window-breaking mechanism of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a stabilized state;

Fig. 7 is a top structural schematic diagram of the flexible cable and the sliding assembly of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention;

Fig. 8 is a structural schematic diagram of the window breaker of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention;

Fig. 9 is a structural schematic diagram of the fire-extinguishing cabin, the window-breaking mechanism and the crawler robot of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a lowered state; and

Fig. 10 is a structural schematic diagram of the fire-extinguishing cabin, the window-breaking mechanism, the crawler robot and the hydraulic telescopic support plate of the intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention in a stabilized state.

In the drawings: 1, fire-extinguishing cabin;

2, hoisting mechanism; 21, first winch; 22, steel wire rope;

3, vertical guide mechanism; 31, second winch; 32, flexible cable; 33, connection seat; 34, first automated guided vehicle; 35, sliding assembly; 351, first bracket; 352, limiting wheel;

4, fire-extinguishing mechanism; 41, high-pressure water pump; 42, water storage tank; 43, water delivery pipe; 44, hose; 45, fire monitor;

5, second automated guided vehicle;

6, horizontal guide mechanism; 61, reinforcing beam; 62, reinforcing column; 63, T-shaped rail beam; 64, second bracket; 65, moving wheel;

7, support mechanism; 71, first hydraulic telescopic arm; 72, support seat; 73, guide wheel; 74, third bracket; 75, first support rod; 76, second support rod;

8, window-breaking mechanism; 81, second hydraulic telescopic arm; 82, manipulator; 83, window breaker; 831, T-shaped block; 832, window-breaking cone; 833, window-breaking teeth; 84, spacing adjustment assembly; 841, bidirectional screw rod; 842, stepper motor; 843, threaded sleeve; 844, guide rod; 845, guide sleeve;

9, crawler robot;

10, hydraulic telescopic support plate.

**Detailed Description of Embodiments**

In order that the above objects, features and advantages of the present invention can be more clearly understood, the present invention is further described below with reference to the drawings and embodiments. It should be noted that, where there is no

conflict, the embodiments of the present application and features in the embodiments may be combined with one another.

The present invention is further described below with reference to the drawings and specific embodiments.

**Embodiment 1**

As shown in Figs. 1 to 10, an intelligent high-altitude fire-fighting apparatus according to an embodiment of the present invention comprises: a fire-extinguishing cabin 1, a hoisting mechanism 2, a vertical guide mechanism 3, a fire-extinguishing mechanism 4, a second automated guided vehicle 5, a horizontal guide mechanism 6, a support mechanism 7 and a window-breaking mechanism 8.

The fire-extinguishing cabin 1 is configured to provide an installation base for a portion of the intelligent high-altitude fire-fighting apparatus and to assist in evacuation and rescue of trapped persons in a building, and the fire-extinguishing cabin 1 is movably arranged outside the building.

The hoisting mechanism 2 is configured to drive the fire-extinguishing cabin 1 to move upwards and downwards, and the hoisting mechanism 2 is arranged on a roof of the building, with the fire-extinguishing cabin 1 being arranged below the hoisting mechanism 2.

The vertical guide mechanism 3 is configured to guide upward and downward movement of the fire-extinguishing cabin 1, and the vertical guide mechanism 3 is arranged between the roof of the building and the ground.

The fire-extinguishing mechanism 4 is configured to cooperate with the fire-extinguishing cabin 1 to perform fire-extinguishing operation on a fire source in the building, and the fire-extinguishing mechanism 4 is arranged on the roof of the building.

The second automated guided vehicle 5 is configured to drive the hoisting mechanism 2, the vertical guide mechanism 3 and the fire-extinguishing mechanism 4 to synchronously perform horizontal movement, and respective structural portions of the hoisting mechanism 2, the vertical guide mechanism 3 and the fire-extinguishing mechanism 4 are arranged on the second automated guided vehicle 5.

The horizontal guide mechanism 6 is configured to guide horizontal movement of the second automated guided vehicle 5, the horizontal guide mechanism 6 is arranged on the roof of the building, and the second automated guided vehicle 5 is movably arranged on the horizontal guide mechanism 6.

The support mechanism 7 is configured to support respective structural portions of the hoisting mechanism 2, the vertical guide mechanism 3 and the fire-extinguishing

mechanism 4, and the support mechanism 7 is arranged on the fire-extinguishing mechanism 4.

The window-breaking mechanism 8 is configured to break a glass window at the fire source of the building and to ensure stability of the fire-extinguishing cabin 1 during fire-extinguishing operation, and the window-breaking mechanism 8 is arranged in an inner cavity of the fire-extinguishing cabin 1.

**Embodiment 2**

As shown in Figs. 3 to 5, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 1 in that:

The hoisting mechanism 2 comprises the first winch 21 and the steel wire rope 22. The first winch 21 is mounted on the top of the second automated guided vehicle 5. One end of the steel wire rope 22 is fixed to and wound on the first winch 21, and the other end of the steel wire rope 22 is fixedly connected to the top of the fire-extinguishing cabin 1. By starting the first winch 21, the steel wire rope 22 can be wound and unwound, thereby enabling upward and downward movement of the fire-extinguishing cabin 1, so as to facilitate subsequent fire-extinguishing operation on fire sources on different floors.

**Embodiment 3**

As shown in Figs. 3 to 7, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 2 in that:

The vertical guide mechanism 3 comprises the second winch 31, the flexible cables 32, the connection seat 33, the first automated guided vehicle 34 and the sliding assemblies 35. The second winch 31 is mounted on the top of the second automated guided vehicle 5. Four flexible cables 32 are fixed to and wound on the second winch 31. The four flexible cables 32 are respectively slidably connected to four corners of the fire-extinguishing cabin 1 by means of the sliding assemblies 35. The other ends of the flexible cables 32 movably pass through to below the fire-extinguishing cabin 1 and are fixedly connected to the connection seat 33. The first automated guided vehicle 34 is mounted at the bottom of the connection seat 33. One sliding assembly 35 is provided at each of the four corners of the top and the bottom of the fire-extinguishing cabin 1. By starting the second winch 31, the flexible cables 32 can be wound and unwound, thereby enabling upward and downward movement of the connection seat 33 and the first automated guided vehicle 34. Thus the flexible cables 32 can be used to guide the fire-extinguishing cabin 1, which helps improve stability when the fire-extinguishing cabin 1 moves upwards and downwards. At the same time, by starting the second automated guided vehicle 5 and the first automated guided vehicle 34, fire-fighting operation can be performed at any location around the

building. The sliding assembly 35 comprises the first bracket 351 mounted on the fire-extinguishing cabin 1. One side of the first bracket 351 is rotatably connected to two symmetrical limiting wheels 352 slidably connected to the flexible cable 32. When the fire-extinguishing cabin 1 moves upwards and downwards along the flexible cable 32, the sliding assembly 35 can be driven to move synchronously, so that the limiting wheels 352 roll on the surface of the flexible cable 32. This helps reduce friction between the flexible cable 32 and the fire-extinguishing cabin 1, avoids jamming when the fire-extinguishing cabin 1 moves upwards and downwards, and further improves the flexibility of the upward and downward movement of the fire-extinguishing cabin 1.

**Embodiment 4**

As shown in Figs. 3 to 6, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 3 in that:

The fire-extinguishing mechanism 4 comprises the high-pressure water pump 41, the water storage tank 42, the water delivery pipe 43, the hose 44 and the fire monitor 45. The high-pressure water pump 41 is mounted on the top of the second automated guided vehicle 5, and the high-pressure water pump 41, the first winch 21 and the second winch 31 are arranged successively from left to right on the top of the second automated guided vehicle 5. The water storage tank 42 is arranged on the top of the horizontal guide mechanism 6, and the top of the water storage tank 42 is of an open structure, which can ensure that the water delivery pipe 43 can normally convey liquid in the inner cavity of the water storage tank 42 when the second automated guided vehicle 5 drives the fire-extinguishing mechanism 4 to move on the roof of the building. One end of the water delivery pipe 43 communicates with the water inlet end of the high-pressure water pump 41, and the other end of the water delivery pipe 43 extends through into the inner cavity of the water storage tank 42. The fire monitor 45 is mounted in the inner cavity of the fire-extinguishing cabin 1. One end of the hose 44 communicates with the water outlet end of the high-pressure water pump 41, and the other end of the hose 44 extends through into the inner cavity of the fire-extinguishing cabin 1 and communicates with the fire monitor 45. By starting the high-pressure water pump 41, the water stored in the inner cavity of the water storage tank 42 can be pumped into the inner cavity of the hose 44 and sprayed out by the fire monitor 45, thereby performing fire-extinguishing operation on the fire source.

**Embodiment 5**

As shown in Fig. 3, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 4 in that:

The horizontal guide mechanism 6 comprises a load-bearing support mechanism configured to raise and support the second automated guided vehicle 5 and the water

storage tank 42, and an anti-overturning mechanism is provided between the load-bearing support mechanism and the second automated guided vehicle 5. The load-bearing support mechanism comprises the reinforcing beam 61 horizontally and fixedly connected to the roof of the building. Reinforcing columns 62 are vertically and fixedly connected to both sides of the reinforcing beam 61. The water storage tank 42 is fixedly connected to the top of one of the reinforcing columns 62. The load-bearing support mechanism can raise the second automated guided vehicle 5 to a desired position, so that the fire-extinguishing cabin 1, the connection seat 33 and the first automated guided vehicle 34 can be located above the roof horizontal line of the building in a standby state, effectively preventing the fire-extinguishing cabin 1 and the vertical guide mechanism 3 from blocking the doors and windows of the building and affecting the appearance. The anti-overturning mechanism comprises the T-shaped rail beam 63 vertically and fixedly connected to the tops of the reinforcing beam 61 and the other reinforcing column 62. Travelling wheels of the second automated guided vehicle 5 are arranged on the top of the T-shaped rail beam 63. Second brackets 64 are mounted on both sides of the bottom of the second automated guided vehicle 5. Bottom ends of the second brackets 64 are rotatably connected to moving wheels 65 cooperating with the T-shaped rail beam 63. When the second automated guided vehicle 5 moves on the top of the T-shaped rail beam 63, the moving wheels 65 can be driven to roll on a side surface of the T-shaped rail beam 63. This can limit movement of the second automated guided vehicle 5, so that the second automated guided vehicle 5 stably moves on the horizontal guide mechanism 6, and can also avoid side overturning caused by relatively large gravity on one side of the top of the second automated guided vehicle 5.

**Embodiment 6**

As shown in Fig. 3, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 5 in that:

The support mechanism 7 comprises the first hydraulic telescopic arm 71 mounted on the top of the second automated guided vehicle 5. The output end of the first hydraulic telescopic arm 71 is fixedly connected to the support seat 72 configured to guide the hose 44. The support seat 72 is rotatably connected to the guide wheel 73 configured to guide and support the steel wire rope 22 and the flexible cables 32. The guide wheel 73 can guide the movement direction of the steel wire rope 22 and the flexible cables 32. By starting the first hydraulic telescopic arm 71, the support seat 72 and the guide wheel 73 can be driven to move synchronously, thereby adjusting the distance between the guide wheel 73 and the building, and thus enabling adjustment of the distance between the fire-extinguishing cabin 1 and the building. The third bracket 74 is fixedly connected to a side, away from the support seat 72, of the top of the first hydraulic telescopic arm 71. The first support rod 75 is slidably

connected to the bottom of the third bracket 74. One end of the first support rod 75 is fixedly connected to the support seat 72. A plurality of second support rods 76 are fixedly connected to the top of the first support rod 75. Top ends of the second support rods 76 are rotatably connected to rollers configured to guide and support the hose 44, and heights of the rollers increase successively from left to right. When the output end of the first hydraulic telescopic arm 71 drives the support seat 72 to move horizontally, the support seat 72 can drive the first support rod 75, the second support rods 76 and the rollers to move synchronously. This helps ensure that the rollers always support the hose 44 and prevents the hose 44 from drooping on the first hydraulic telescopic arm 71.

**Embodiment 7**

As shown in Figs. 4, 5, 6 and 8, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 6 in that:

One window-breaking mechanism 8 is provided at each of the upper portion and the lower portion of the inner cavity of the fire-extinguishing cabin 1.

The window-breaking mechanism 8 comprises two second hydraulic telescopic arms 81, manipulators 82 and window breakers 83. The output ends of the second hydraulic telescopic arms 81 are fixedly connected to the manipulators 82. The window breakers 83 are arranged on sides of the manipulators 82 away from the second hydraulic telescopic arms 81. By starting the manipulators 82, the window breakers 83 can be made to face the glass window of the building. By starting the second hydraulic telescopic arms 81, the distance between the window breakers 83 and the glass window of the building can be adjusted, so as to facilitate window-breaking operation by the window breakers 83. Subsequently, the manipulators 82 can grasp the glass window frame, thereby stabilizing the fire-extinguishing cabin 1. The window breaker 83 comprises the T-shaped block 831 fixedly connected to the claws of the manipulator 82. The window-breaking cone 832 is fixedly connected to a side of the T-shaped block 831 away from the manipulator 82. A plurality of regularly distributed window-breaking teeth 833 are fixedly connected to a side of the T-shaped block 831 close to the window-breaking cone 832. Through cooperative use of the window-breaking cone 832 and the window-breaking teeth 833, glass can be broken, so as to facilitate subsequent fire-fighting and fire-extinguishing operation. The window-breaking mechanism 8 further comprises the spacing adjustment assembly 84 configured to adjust a spacing between two second hydraulic telescopic arms 81 on the same horizontal line. The spacing adjustment assembly 84 comprises the bidirectional screw rod 841 horizontally and rotatably connected in the inner cavity of the fire-extinguishing cabin 1. The stepper motor 842 configured to drive the bidirectional screw rod 841 to rotate

is mounted on the inner wall surface of the fire-extinguishing cabin 1. Each second hydraulic telescopic arm 81 is fixedly connected to one threaded sleeve 843. Two threaded sleeves 843 on the same horizontal line are respectively threadedly sleeved on two sides of a surface of the corresponding bidirectional screw rod 841. A limiting mechanism for guiding is provided between each second hydraulic telescopic arm 81 and the fire-extinguishing cabin 1. By starting the stepper motor 842, the bidirectional screw rod 841 can be driven to rotate. Under the action of threads, two second hydraulic telescopic arms 81 on the bidirectional screw rod 841 can be driven to synchronously move towards or away from each other, thereby enabling window-breaking operation on glass windows having different widths. The limiting mechanism comprises two guide rods 844 symmetrically arranged on two sides of the bidirectional screw rod 841. Guide sleeves 845 are fixedly connected to both sides of the bottom of the second hydraulic telescopic arm 81. The guide sleeves 845 are slidably sleeved on surfaces of the corresponding guide rods 844. When the second hydraulic telescopic arm 81 moves, the second hydraulic telescopic arm 81 can drive the guide sleeves 845 to slide on the surfaces of the guide rods 844, so that the second hydraulic telescopic arm 81 can stably move horizontally, thereby effectively preventing the second hydraulic telescopic arm 81 from rotating synchronously with the bidirectional screw rod 841.

**Embodiment 8**

As shown in Figs. 9 and 10, the intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 7 in that:

One window-breaking mechanism 8 is provided at the upper portion of the inner cavity of the fire-extinguishing cabin 1.

The window-breaking mechanism 8 comprises the second hydraulic telescopic arm 81, the manipulator 82 and the window breaker 83. The output end of the second hydraulic telescopic arm 81 is fixedly connected to the manipulator 82. The window breaker 83 is arranged on a side of the manipulator 82 away from the second hydraulic telescopic arm 81. Two second hydraulic telescopic arms 81 are symmetrically provided on the spacing adjustment assembly 84. By starting the manipulator 82, the window breaker 83 can be made to face the glass window of the building. By starting the second hydraulic telescopic arm 81, the distance between the window breaker 83 and the glass window of the building can be adjusted, so as to facilitate window-breaking operation by the window breaker 83. Subsequently, the manipulator 82 can grasp the glass window frame, thereby stabilizing the fire-extinguishing cabin 1. The window breaker 83 comprises the T-shaped block 831 fixedly connected to the claws of the manipulator 82. The window-breaking cone 832 is fixedly connected to a side of the T-shaped block 831 away from the manipulator

82. A plurality of regularly distributed window-breaking teeth 833 are fixedly connected to a side of the T-shaped block 831 close to the window-breaking cone 832. Through cooperative use of the window-breaking cone 832 and the window-breaking teeth 833, glass can be broken, so as to facilitate subsequent fire-fighting and fire-extinguishing operation. The window-breaking mechanism 8 further comprises the spacing adjustment assembly 84 configured to adjust a spacing between two second hydraulic telescopic arms 81 on the same horizontal line. The spacing adjustment assembly 84 comprises the bidirectional screw rod 841 horizontally and rotatably connected in the inner cavity of the fire-extinguishing cabin 1. The stepper motor 842 configured to drive the bidirectional screw rod 841 to rotate is mounted on the inner wall surface of the fire-extinguishing cabin 1. Each second hydraulic telescopic arm 81 is fixedly connected to one threaded sleeve 843. Two threaded sleeves 843 on the same horizontal line are respectively threadedly sleeved on two sides of a surface of the corresponding bidirectional screw rod 841. A limiting mechanism for guiding is provided between each second hydraulic telescopic arm 81 and the fire-extinguishing cabin 1. By starting the stepper motor 842, the bidirectional screw rod 841 can be driven to rotate. Under the action of threads, two second hydraulic telescopic arms 81 on the bidirectional screw rod 841 can be driven to synchronously move towards or away from each other, thereby enabling window-breaking operation on glass windows having different widths. The limiting mechanism comprises two guide rods 844 symmetrically arranged on two sides of the bidirectional screw rod 841. Guide sleeves 845 are fixedly connected to both sides of the bottom of the second hydraulic telescopic arm 81. The guide sleeves 845 are slidably sleeved on surfaces of the corresponding guide rods 844. When the second hydraulic telescopic arm 81 moves, the second hydraulic telescopic arm 81 can drive the guide sleeves 845 to slide on the surfaces of the guide rods 844, so that the second hydraulic telescopic arm 81 can stably move horizontally, thereby effectively preventing the second hydraulic telescopic arm 81 from rotating synchronously with the bidirectional screw rod 841.

The crawler robot 9 is placed in the inner cavity of the fire-extinguishing cabin 1, and the crawler robot 9 can be used to assist in fire-extinguishing operation. The hydraulic telescopic support plate 10 is mounted below the inner cavity of the fire-extinguishing cabin 1. According to actual circumstances, the hydraulic telescopic support plate 10 may be started so that a free end thereof is lapped on a lower part inside the window frame, and the crawler robot 9 may then enter the interior of the building from the hydraulic telescopic support plate 10 to perform situation survey.

**Embodiment 9**

The intelligent high-altitude fire-fighting apparatus provided by this embodiment differs from Embodiment 8 in that:

A central control system electrically connected to the first winch 21, the second winch 31, the first automated guided vehicle 34, the high-pressure water pump 41, the fire monitor 45, the second automated guided vehicle 5, the first hydraulic telescopic arm 71, the second hydraulic telescopic arm 81, the manipulator 82, the stepper motor 842, the crawler robot 9 and the hydraulic telescopic support plate 10 is provided on the roof of the building. The central control system is configured to adjust the working states or parameters of the first winch 21, the second winch 31, the first automated guided vehicle 34, the high-pressure water pump 41, the fire monitor 45, the second automated guided vehicle 5, the first hydraulic telescopic arm 71, the second hydraulic telescopic arm 81, the manipulator 82, the stepper motor 842, the crawler robot 9 and the hydraulic telescopic support plate 10, and is further configured to be connected to a fire alarm system of the building. A power supply system electrically connected to the first winch 21, the second winch 31, the first automated guided vehicle 34, the high-pressure water pump 41, the fire monitor 45, the second automated guided vehicle 5, the first hydraulic telescopic arm 71, the second hydraulic telescopic arm 81, the manipulator 82, the stepper motor 842, the crawler robot 9, the hydraulic telescopic support plate 10 and the central control system is further provided on the roof of the building.

The working principle of the present invention is briefly described below:

Lowering the fire-extinguishing cabin 1: the first hydraulic telescopic arm 71 is started, and the first hydraulic telescopic arm 71 drives the support seat 72, the guide wheel 73, the first support rod 75 and the second support rods 76 to move synchronously, so that the distance between the guide wheel 73 and the building can be adjusted to facilitate subsequent lowering of the fire-extinguishing cabin 1. The second winch 31 is started, and the second winch 31 unwinds the flexible cables 32. The connection seat 33 and the first automated guided vehicle 34 descend under their own gravity until the first automated guided vehicle 34 lands on the ground. The first automated guided vehicle 34 on the ground and the second automated guided vehicle 5 on the roof automatically locate and align with the orientation of the fire source. The second automated guided vehicle 5 drives the hoisting mechanism 2, the vertical guide mechanism 3, the fire-extinguishing mechanism 4, the second brackets 64, the moving wheels 65 and the support mechanism 7 to move synchronously. The moving wheels 65 roll on the side surface of the T-shaped rail beam 63, thereby driving the fire-extinguishing cabin 1 to synchronously move horizontally outside the building. After automatic positioning is completed, the first winch 21 is started, and the first winch 21 unwinds the steel wire rope 22. The fire-extinguishing cabin 1 descends

under its own gravity. The fire-extinguishing cabin 1 drives the first brackets 351 and the limiting wheels 352 to move synchronously, and the limiting wheels 352 roll on the surfaces of the flexible cables 32 until the fire-extinguishing cabin 1 descends from a high-altitude position to the height position of the fire source, thereby completing lowering of the fire-extinguishing cabin 1;

Window breaking and stabilization of the fire-extinguishing cabin 1: the stepper motor 842 is started, and an output shaft of the stepper motor 842 drives the bidirectional screw rod 841 to rotate. Under the action of threads, the bidirectional screw rod 841 drives two threaded sleeves 843 on its surface to move towards or away from each other. Each threaded sleeve 843 drives the corresponding second hydraulic telescopic arm 81 to move synchronously, and the second hydraulic telescopic arm 81 drives the guide sleeves 845 to slide on the surfaces of the guide rods 844. Accordingly, the spacing between two manipulators 82 on the same horizontal line can be adjusted according to the width of the glass window. The second hydraulic telescopic arms 81 are started, so that the second hydraulic telescopic arms 81 drive the manipulators 82 and the window breakers 83 to approach the position of the window frame. The manipulators 82 are started, and the claws of the manipulators 82 drive the window breakers 83 to be inserted forwards and break the glass window. At the same time, the claws of the manipulators 82 grasp the glass window frame, so that the fire-extinguishing cabin 1 has an anchoring point. This effectively prevents the fire-extinguishing cabin 1 from drifting and shaking in strong wind, thereby completing window breaking and stabilization of the fire-extinguishing cabin 1;

Extinguishing the fire source: the high-pressure water pump 41 is started, and the high-pressure water pump 41 conveys water stored in the inner cavity of the water storage tank 42 to the inner cavity of the hose 44 through the water delivery pipe 43. Finally, the fire monitor 45 is aligned with the fire source of the fire scene to perform effective fire-extinguishing operation, thereby completing extinguishment of the fire source.

In summary, in the intelligent high-altitude fire-fighting apparatus, by additionally providing the fire-extinguishing cabin 1, the hoisting mechanism 2, the vertical guide mechanism 3 and the fire-extinguishing mechanism 4 on the roof of the building, when a fire occurs, the fire-extinguishing cabin 1 suspended above the roof of the building can be moved to the height position of the fire source of the building through cooperative use of the hoisting mechanism 2 and the vertical guide mechanism 3, and the fire-extinguishing mechanism 4 performs fire-extinguishing operation on the fire source, thereby enabling automatic and prompt fire-fighting operation without manual operation by personnel and achieving the effects of saving physical strength of firefighters and improving fire rescue efficiency. By additionally providing the second

automated guided vehicle 5 and the horizontal guide mechanism 6 on the roof of the building, when a fire occurs, through cooperative use of the vertical guide mechanism 3, the second automated guided vehicle 5 and the horizontal guide mechanism 6, the fire-extinguishing cabin 1 can be moved to any location around the building to perform a fire-fighting or rescue task, thereby expanding the use range of the intelligent high-altitude fire-fighting apparatus. Through cooperative use of the support mechanism 7 and the window-breaking mechanism 8, when a fire occurs, the support mechanism 7 can adjust the distance between the fire-extinguishing cabin 1 and the outer wall of the building. The window-breaking mechanism 8 can perform a window-breaking operation on the glass window of the building and can also stabilize the fire-extinguishing cabin 1, so that the fire-extinguishing cabin 1 has an anchoring point. This effectively prevents the fire-extinguishing cabin 1 from drifting and shaking under high wind speed, thereby ensuring that the fire-extinguishing mechanism 4 is aligned with the fire source of the fire scene for effective fire-extinguishing operation, and thus ensuring the automatic fire-extinguishing effect for a high-rise building.

Those skilled in the technical field can readily implement the present invention according to the above detailed description. However, it should be understood that the present invention is not limited to the above detailed embodiments. On the basis of the disclosed embodiments, those skilled in the technical field may arbitrarily combine different technical features so as to implement different technical solutions.

## Claims

1. An intelligent high-altitude fire-fighting apparatus, comprising:

a fire-extinguishing cabin (1), configured to provide an installation base for a portion of the intelligent high-altitude fire-fighting apparatus and to assist in evacuation and rescue of trapped persons in a building, wherein the fire-extinguishing cabin (1) is movably arranged outside the building;

a hoisting mechanism (2), configured to drive the fire-extinguishing cabin (1) to move upwards and downwards, wherein the hoisting mechanism (2) is arranged on a roof of the building, and the fire-extinguishing cabin (1) is arranged below the hoisting mechanism (2);

a vertical guide mechanism (3), configured to guide upward and downward movement of the fire-extinguishing cabin (1), wherein the vertical guide mechanism (3) is arranged between the roof of the building and the ground;

a fire-extinguishing mechanism (4), configured to cooperate with the fire-extinguishing cabin (1) to perform fire-extinguishing operation on a fire source in the building, wherein the fire-extinguishing mechanism (4) is arranged on the roof of the building;

a second automated guided vehicle (5), configured to drive the hoisting mechanism (2), the vertical guide mechanism (3) and the fire-extinguishing mechanism (4) to synchronously perform horizontal movement, wherein respective structural portions of the hoisting mechanism (2), the vertical guide mechanism (3) and the fire-extinguishing mechanism (4) are arranged on the second automated guided vehicle (5);

a horizontal guide mechanism (6), configured to guide horizontal movement of the second automated guided vehicle (5), wherein the horizontal guide mechanism (6) is arranged on the roof of the building, and the second automated guided vehicle (5) is movably arranged on the horizontal guide mechanism (6);

a support mechanism (7), configured to support respective structural portions of the hoisting mechanism (2), the vertical guide mechanism (3) and the fire-extinguishing mechanism (4), wherein the support mechanism (7) is arranged on the fire-extinguishing mechanism (4); and

a window-breaking mechanism (8), configured to break a glass window at the fire source of the building and to ensure stability of the fire-extinguishing cabin (1) during fire-extinguishing operation, wherein the window-breaking mechanism (8) is arranged in an inner cavity of the fire-extinguishing cabin (1).

2. The apparatus according to claim 1, wherein the hoisting mechanism (2) comprises a first winch (21) and a steel wire rope (22), the first winch (21) is mounted on a top of the second automated guided vehicle (5), one end of the steel wire rope (22) is fixed to and wound on the first winch (21), and the other end of the steel wire rope (22) is fixedly connected to a top of the fire-extinguishing cabin (1);

the vertical guide mechanism (3) comprises a second winch (31), flexible cables (32), a connection seat (33), a first automated guided vehicle (34) and sliding assemblies (35), the second winch (31) is mounted on the top of the second automated guided vehicle (5), four flexible cables (32) are fixed to and wound on the second winch (31), the four flexible cables (32) are respectively slidably connected to four corners of the fire-extinguishing cabin (1) by means of the sliding assemblies (35), the other ends of

the flexible cables (32) movably pass through to below the fire-extinguishing cabin (1) and are fixedly connected to the connection seat (33), the first automated guided vehicle (34) is mounted at a bottom of the connection seat (33), and one sliding assembly (35) is provided at each of the four corners of the top and the bottom of the fire-extinguishing cabin (1);

the fire-extinguishing mechanism (4) comprises a high-pressure water pump (41), a water storage tank (42), a water delivery pipe (43), a hose (44) and a fire monitor (45), the high-pressure water pump (41) is mounted on the top of the second automated guided vehicle (5), the water storage tank (42) is arranged on a top of the horizontal guide mechanism (6), one end of the water delivery pipe (43) communicates with a water inlet end of the high-pressure water pump (41), the other end of the water delivery pipe (43) extends through into an inner cavity of the water storage tank (42), the fire monitor (45) is mounted in the inner cavity of the fire-extinguishing cabin (1), one end of the hose (44) communicates with a water outlet end of the high-pressure water pump (41), and the other end of the hose (44) extends through into the inner cavity of the fire-extinguishing cabin (1) and communicates with the fire monitor (45);

one window-breaking mechanism (8) is provided at each of an upper portion and a lower portion of the inner cavity of the fire-extinguishing cabin (1);

the window-breaking mechanism (8) comprises two second hydraulic telescopic arms (81), manipulators (82) and window breakers (83), output ends of the second hydraulic telescopic arms (81) are fixedly connected to the manipulators (82), and the window breakers (83) are arranged on sides of the manipulators (82) away from the second hydraulic telescopic arms (81);

the window-breaking mechanism (8) further comprises a spacing adjustment assembly (84) configured to adjust a spacing between two second hydraulic telescopic arms (81) on the same horizontal line; and

the spacing adjustment assembly (84) comprises a bidirectional screw rod (841) horizontally and rotatably connected in the inner cavity of the fire-extinguishing cabin (1), a stepper motor (842) configured to drive the bidirectional screw rod (841) to rotate is mounted on an inner wall surface of the fire-extinguishing cabin (1), each of the second hydraulic telescopic arms (81) is fixedly connected to a threaded sleeve (843), two threaded sleeves (843) on the same horizontal line are respectively

threadedly sleeved on two sides of a surface of the corresponding bidirectional screw rod (841), and a limiting mechanism for guiding is provided between each second hydraulic telescopic arm (81) and the fire-extinguishing cabin (1).

3. The apparatus according to claim 2, wherein the sliding assembly (35) comprises a first bracket (351) mounted on the fire-extinguishing cabin (1), and one side of the first bracket (351) is rotatably connected to two symmetrical limiting wheels (352) slidably connected to the flexible cable (32).

4. The apparatus according to claim 2, wherein the horizontal guide mechanism (6) comprises a load-bearing support mechanism configured to raise and support the second automated guided vehicle (5) and the water storage tank (42), and an anti-overturning mechanism is provided between the load-bearing support mechanism and the second automated guided vehicle (5).

5. The apparatus according to claim 4, wherein the load-bearing support mechanism comprises a reinforcing beam (61) fixedly connected to the roof of the building, reinforcing columns (62) are fixedly connected to both sides of the reinforcing beam (61), and the water storage tank (42) is fixedly connected to a top of one of the reinforcing columns (62).

6. The apparatus according to claim 5, wherein the anti-overturning mechanism comprises a T-shaped rail beam (63) fixedly connected to tops of the reinforcing beam (61) and the other reinforcing column (62), travelling wheels of the second automated guided vehicle (5) are arranged on a top of the T-shaped rail beam (63), second brackets (64) are mounted on both sides of a bottom of the second automated guided vehicle (5), and bottom ends of the second brackets (64) are rotatably connected to moving wheels (65) cooperating with the T-shaped rail beam (63).

7. The apparatus according to claim 2, wherein the support mechanism (7) comprises a first hydraulic telescopic arm (71) mounted on the top of the second automated guided vehicle (5), an output end of the first hydraulic telescopic arm (71) is fixedly connected to a support seat (72) configured to guide the hose (44), and the support seat (72) is rotatably connected to a guide wheel (73) configured to guide and support the steel wire rope (22) and the flexible cables (32).

8. The apparatus according to claim 7, wherein a third bracket (74) is fixedly connected to a side, away from the support seat (72), of a top of the first hydraulic telescopic arm (71), a first support rod (75) is slidably connected to a bottom of the

third bracket (74), one end of the first support rod (75) is fixedly connected to the support seat (72), a plurality of second support rods (76) are fixedly connected to a top of the first support rod (75), top ends of the second support rods (76) are rotatably connected to rollers configured to guide and support the hose (44), and heights of the rollers increase successively from left to right.

9. The apparatus according to claim 2, wherein the window breaker (83) comprises a T-shaped block (831) fixedly connected to claws of the manipulator (82), a window-breaking cone (832) is fixedly connected to a side of the T-shaped block (831) away from the manipulator (82), and a plurality of regularly distributed window-breaking teeth (833) are fixedly connected to a side of the T-shaped block (831) close to the window-breaking cone (832).

10. The apparatus according to claim 2, wherein the limiting mechanism comprises two guide rods (844) symmetrically arranged on two sides of the bidirectional screw rod (841), guide sleeves (845) are fixedly connected to both sides of a bottom of the second hydraulic telescopic arm (81), and the guide sleeves (845) are slidably sleeved on surfaces of the corresponding guide rods (844).